IN THE DRAWINGS

Please replace Sheets 1-3 with the enclosed Replacement Sheets 1-3.

REMARKS

Claims 1-43 are pending in the subject application. Of those claims, claims 30-37 are withdrawn as a result of a restriction requirement and claims 19-29 and 38-43 are rejected. More specifically, claims 28-42 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claims 19, 20, 26, 28, 29 and 38-43 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 6,136,682 to Hegde et al., and claims 38-43 are rejected under 35 U.S.C. § 103(a) as being obvious in view of Hegde et al. Similarly, claims 21 and 23-25 are rejected under 35 U.S.C. § 103(a) as being obvious over Hegde et al. as applied to claim 20, and further in combination with U.S. Publication 20030227068 by Li. Claims 19, 20 and 22 are also rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Publication 20040026119 by Chen. Claim 27 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Hegde et al. as applied to claim 20, and further in combination with U.S. Patent 6,828,189 to Igarashi. Lastly, the Examiner objected to Figs. 1 and 2 as not including a Prior Art legend.

The foregoing rejections are respectfully disagreed with, and are traversed below.

Regarding the Examiner's objection to Figs. 1 and 2, a Prior Art legend has been added to these figures as requested by the Examiner. Accordingly, Replacement Sheets are submitted herewith for prior Sheets 1-3. Reconsideration and withdrawal of the objection to the Drawings is thus warranted.

Independent claims 19, 38, 41 and 43 have been clarified to specify that each layer has a thickness of about 0.4 to about 4.5 nm, as supported by page 7, lines 2-5, of the specification.

Claims 39-41 have also been clarified, as suggested by the Examiner, to provide further antecedent basis. Regarding the Examiner's assertion that there is no antecedent basis for "the barrier" in the last line of claim 38, the Examiner's attention is directed to line 1 of this claim reciting a "multilayer diffusion barrier." In view of the foregoing, the Examiner's rejections under 35 USC § 112, second paragraph,

should be reconsidered and withdrawn.

Regarding the rejections based upon art, it is respectfully asserted that the cited references, whether viewed alone or in any combination, do not disclose nor suggest the subject claims for at least the following reasons.

Independent claim 19 recites:

> 19. A diffusion barrier comprising a plurality of stacked sub-layers, each sub-layer having a thickness of about 0.4 to about 4.5 nm, which is predetermined to inhibit the formation of a crystalline lattice, to inhibit diffusion of a chemical species through the diffusion barrier.

Similarly, independent claims 38, 41 and 43 recite:

> 38. A multilayer diffusion barrier comprised of atomically thin films in which the surface adhesion of each interface inhibits the formation of a lattice in the bulk of the individual film layers, inhibiting diffusion across the barrier, wherein thickness of each film is in a range of about 0.4 to about 4.5 nm.
>
> 41. A multilayer structure comprised of three or more sub-layers each having a thickness of about 0.4 to about 4.5 nm and an interface, wherein the interface of each of the sub-layers dominates a lattice formation on the sub-layers, preventing the formation of a lattice and grain boundaries, to inhibit diffusion of a chemical species through the structure.
>
> 43. A multilayer diffusion barrier for inhibiting diffusion of chemical species there through, comprising a plurality of stacked layers comprised of alternating films of at least two different metals, the thickness of each of said films being between about 0.4 to about 4.5 nm, which is predetermined to substantially eliminate work hardening.

Claims 20-29, 39-40 and 42 depend from an independent claim and recite further advantageous features of the claimed barrier or multilayer structure.

It is respectfully asserted that the foregoing claimed features are not disclose in, nor suggested by, the cited art. In particular, Hegde et al. disclose a TiN layer deposited over a TaN layer. The collective thickness of the TiNi and TaN layer is 400 angstroms or less. A copper material is then deposited over the TiN layer (Abstract). As further disclosed at col. 3, lines 59-67, 0-200 angstroms define the TiN amorphous barrier region and 200-400 angstroms define the TaN or TaSiN layer. Preferably, the TaN or TaSiN layer is between 20 angstroms and 200 angstroms, as disclosed at col. 4, lines 42-52. At col. 2, line 65- col. 3, line 5, Hegde et al. state that the TaN "deposits in an amorphous state" and at col. 4, lines 48-53 Hedge et al. refer to physical vapor deposition. However, there does not appear to be any specific teachings as how to achieve amorphous deposition. Moreover, at col. 3 Hedge et al. cite experiments and assert that there is an unexpected benefit of a 400 angstrom composite of TiN and TaN.

The Examiner recognizes at page 6 of the Action that Hegde et al. do not disclose the claimed thickness limitations, but asserts that Applicants have not demonstrated that their dimensions are for a "particular unobvious purpose" or show unexpected results.

Applicants assert that unexpected results are present as a result of the claimed invention. For example, in contrast to Hegde et al. and as disclosed in the specification at page 4, Applicants have determined how to form a very thin, multilayer diffusion barrier composed of even thinner sub-layers, where the sub-layers are only a few atoms thick. A strong bond between each of the sub-layers perturbs the regular crystalline structure of the sub-layer, as long as the sub-layer remains very thin. Since the surface energies dominate the bulk binding energies, the sub-layer remains disordered and essentially free of a regular crystalline structure. The lack of formation of a lattice within each sub-layer results in no grain boundary formation, and hence, no pathways for inter diffusion through the barrier.

Hegde et al. do not disclose or suggest such a barrier including, for example, each sub-layer having a specific thickness between about 0.4 and about 4.5 angstroms, wherein formation of crystalline lattice and diffusion of a chemical species through

the barrier is inhibited. Hegde et al. particularly teach that "unexpected results" are obtained with a 400 angstrom composite. There is no description in Hedge et al. of the claimed structure at the claimed nanometer scale.

Nor does this reference disclose or suggest the claimed multilayer diffusion barrier including the afore-referenced film thickness, wherein the surface adhesion of each interface inhibits the formation of a lattice in the individual film layers inhibiting diffusion across the barrier, or comprising alternating films of at least two different metals wherein work hardening is substantially eliminated. Nor is the particularly claimed multilayer structure of the claimed thickness disclosed or suggested.

The addition of Li et al., Chen and/or Igarashi does not cure the shortcomings of Hegde et al. for at least the following reasons. Li et al. relate to a sputtering target. While Li et al. may generally mention a grain size less than 1 nm, Li et al. do not disclose or suggest any structure including the particularly claimed thin layers, wherein formation of a crystalline lattice is inhibited.

Chen discloses a semiconductor device including a barrier layer comprising an amorphous metallic glass. Chen does not disclose any structure as claimed herein including the specified thickness. At page 8 of the Action, the Examiner asserts that at paragraphs 25 and 26, "Chen discloses a diffusion barrier comprising a plurality of stacked sub-layers 6, each sub-layer having a thickness predetermined to inhibit the formation of a crystalline lattice, to inhibit diffusion of a chemical species ...." Applicants respectfully disagree. Paragraph 25 of Chen describes an amorphous metallic glass barrier and its effect on surface free energy, which allows the next layer deposited to be more textured. In paragraph 26, Chen discloses a layered structure of the preferred layer of amorphous metallic glass and additional layers of a variety of compounds of nitrides and carbides, which do not appear to be described as amorphous.

Lastly, Igarashi relates to the blocking of hydrogen diffusion with the use of oxide films and was particularly cited by the Examiner as disclosing tantalum oxide. This

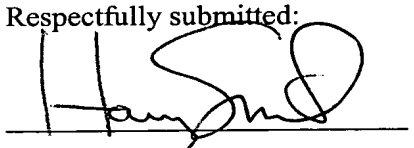
disclosure in combination with any/all of the afore-cited references does not disclose or suggest the claimed invention for the reasons set forth above.

In view of the foregoing, it is asserted that there is no teaching or suggestion that would motivate one of ordinary skill in the art to combine and modify the cited references in an attempt to arrive at the subject claims. Without such a teaching, suggestion or motivation, the invention may only be considered obvious in hindsight, which is an improper basis for rejection.

New claims 44-53 are also added by amendment herewith. Support for these claims exists throughout the specification at, for example, pages, 1, 4, 7 and 9.

All issues having been addressed, the subject patent application is believed to be in condition for immediate allowance. Accordingly, the Examiner is respectfully requested to reconsider and remove the outstanding rejections and objection. An early notification of the allowance is earnestly solicited.

Respectfully submitted:



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December 28, 2005 — Date

D. Morgan — Name of Person Making Deposit